

CLAIMS

We claim:

1. A modular fluid system comprising:
first and second support members;
a substrate for connection with said first and second support members in an orientation generally transverse to an axis of said first and second support members;
said substrate having a fluid passage for directing fluid along a length of said substrate; and
a clamp for releasably clamping said substrate to one or more of said support members.
2. A system as set forth in claim 1 wherein said clamp comprises a blocking portion of said first support member and a drive block movable along the length of said first support member in a direction toward said blocking portion to clamp said substrate between said drive block and said blocking portion.
3. A system as set forth in claim 1 wherein a clamping force is directed generally along said axis of said first support member and generally perpendicular to said substrate.
4. A system as set forth in claim 1 wherein said substrate has opposite side surfaces and said clamp exerts a clamping force on said opposite side surfaces in a direction along said axis of said first support member.
5. The system of claim 1 wherein said substrate is secured to said support member by a compressive clamping force without a threaded engagement therebetween.
6. A modular fluid system comprising:
first and second support members;
a substrate for connection with said first and second support members in an orientation extending transverse to the length of said first and second support members;
said first and second support members being adapted to receive a plurality of said substrates at locations along the length of said first and second support members;

said substrate having a fluid passage for directing fluid along a portion of said substrate; and

a bolt movable between a first condition threaded in said first support member and securing said substrate tightly to said first support member and a second condition threaded in said first support member and enabling removal of said substrate from said first support member, without forming a threaded connection between said support member and substrate.

7. A system as set forth in claim 6 wherein said bolt does not extend through said substrate.

8. A system as set forth in claim 6 wherein said bolt moves axially as it is threadably rotated in said substrate, said system further comprising a wedge interposed between said bolt and said substrate and movable axially with said bolt.

9. A system as set forth in claim 8 further comprising a drive block interposed between said wedge and said substrate, said drive block moving in a direction transverse to the axial direction of movement of said wedge and parallel to the length of said first support member in response to axial movement of said bolt.

10. A modular fluid system comprising:
first and second elongate support members;
an elongate substrate for connection with said first and second support members in an orientation extending transverse to the length of said first and second support members;
said substrate having a fluid passage for directing fluid between along the length of said substrate; and
a wedge for releasably securing said substrate to said first support member.

11. A system as set forth in claim 10 wherein said wedge is movable in a first direction transverse to the length of said substrate and transverse to the length of said first support member to releasably secure said substrate to said first support member.

12. A system as set forth in claim 11 wherein said wedge cooperates with an inclined surface on said first support member to provide a first mechanical advantage in releasably securing said substrate to said first support member.

13. A system as set forth in claim 12 further including a threaded fastener for moving said wedge in the first direction to provide a second mechanical advantage in releasably securing said substrate to said first support member.

14. A system as set forth in claim 13 further including a bolt extending through said wedge and movable between a first condition threaded in said first support member and securing said wedge and said substrate tightly to said first support member and a second condition threaded in said first support member and enabling removal of said substrate from said first support member.

15. A method of assembling and disassembling selected parts of a gas supply system, said method comprising the steps of:

- placing a substrate on a support member;
- threading a bolt into the support member to releasably secure the substrate to the support member;
- loosening the bolt without unthreading it from the support member; and
- removing the substrate from the support member when the bolt is loosened but not unthreaded from the support member.

16. A method as set forth in claim 15 wherein said step of threading a bolt into the support member includes threading the bolt into the support member without moving the bolt through an opening in the substrate.

17. A method of assembling and disassembling selected parts of a modular fluid flow system, said method comprising the steps of:

- placing a substrate on a support member; and
- moving a member against said substrate to apply a releasable force to secure said substrate to said support member without a threaded connection therebetween.

18. A method as set forth in claim 17 wherein said step of moving a member comprises moving a wedge in a first direction relative to the support member and causing the substrate to be clamped in a second direction relative to the support member that is transverse to the first direction.

19. A modular fluid system comprising:
first and second support members;
a substrate for connection with said first and second support members in an orientation generally transverse to an axis of said first and second support members;
said substrate having a fluid passage therein; and
means for applying a releasable force to secure said substrate to one or more of said support members without a threaded engagement between said substrate and said one or more support members.

20. A modular fluid system comprising:
generally parallel first and second support members spaced apart from each other and defining a plurality of substrate locations spaced apart by a predetermined distance along the length of said support members;
a substrate engageable with said first and second support members to place said substrate in a selected one of said plurality of substrate locations extending between said first and second support members, said substrate having a component mounting surface and a plurality of component mounting locations; and
at least one fluid flow component mountable on said component mounting surface of said substrate at a selected one of said component mounting locations;
said substrate having an overall first width as defined by outer surfaces of said substrate that is equal to or less than said predetermined distance;
said substrate having a second width, less than said first width, at selected areas along the length of said substrate between said first and second end portions of said substrate.

21. A system as set forth in claim 20 wherein said selected areas of said substrate are within said component mounting locations.

22. A system as set forth in claim 20 wherein each one of said component mounting locations is defined by a set of fastener openings in said substrate for receiving fasteners for fastening said at least one fluid flow component to said substrate.

23. A system for supplying fluid to a plurality of fluid flow components such as valves, filters, mass flow controllers and the like each having an inlet port and an outlet port, said system comprising:

first and second support members each having a plurality of mounting locations;
and

a substrate mountable to said first and second support members;
said substrate having a flow passage formed in a central portion thereof;
said substrate having a plurality of component mounting portions extending laterally outward from said central portion for supporting flow components mounted on said substrate;

air flow passageways formed between adjacent ones of said component mounting portions.

24. A substrate for a modular fluid flow system, said substrate being adapted to support one or more surface mount components thereon, the substrate comprising:

a main body with one or more flow passages formed therein;
a plurality of component mounting portions extending laterally outward from said main body for supporting flow components mountable thereon;

air flow passageways formed between adjacent ones of said component mounting portions.

25. The substrate of claim 24 comprising cast metal.

26. A valve comprising:

a valve base having a surface;
first and second fluid flow ports in said surface; said first and second fluid flow ports being collinear with each other along an axis;

a third port in said surface, said third port being positioned other than collinear with said axis; and

a passage in said valve through which said third port can be selectively connected in fluid communication with one or more of said first and second ports in said valve base.

27. A valve as set forth in claim 26 wherein said valve is operable between the closed and open conditions by movement of a diaphragm inside said valve.

28. A valve as set forth in claim 27 for mounting on a substrate that has one or more sets of two ports along its length, each set of two ports on the substrate being adapted to communicate with said first and second ports of the valve when mounted thereon.

29. A valve as set forth in claim 28 wherein the substrate has a plurality of identical predetermined mounting locations for supporting fluid components, each one of the mounting locations having exactly two ports that connect with the fluid channel in the substrate, and wherein said valve base has a plurality of fastener openings for receiving fasteners for fastening said valve to the substrate at a selected one of the mounting locations of the substrate in a fastened condition in which said collinear first and second ports in said mounting surface of said valve base overlie the exactly two ports in the selected mounting location of the substrate and said third port in said mounting surface of said valve base does not overlie the substrate.

30. A valve comprising:
a valve body with a surface thereon; and three co-planar fluid ports formed in said surface and that are not collinear with respect to each other.

31. The valve of claim 30 wherein one of said three fluid ports is a purge port for the valve.

32. The valve of claim 30 wherein said valve comprises cast metal.

33. A method of forming a component having a seal surface, said method comprising the steps of:

providing a metal body having a first portion on which a seal surface is to be formed surface and having an adjacent second portion; and

work hardening the first portion of the metal body to form the seal surface of the component.

34. A method as set forth in claim 33 wherein said step of work hardening includes deforming the first portion of the metal body with at least one deforming member thereby to form the seal surface of the component.

35. A method as set forth in claim 34 wherein said step of work hardening includes deforming the first portion of the metal body sequentially with at least first and second deforming members thereby to form the seal surface of the component.

36. A method as set forth in claim 33 wherein said step of work hardening the first portion of the metal body to form the seal surface of the component comprises forming a seal surface on a recessed portion of the component.

37. A method as set forth in claim 33 wherein said step of providing a metal body includes providing a metal body that is formed as one piece including the first portion and the second portion.

38. A method as set forth in claim 37 wherein said step of providing a metal body includes providing a metal body that is formed by casting, or by pressing and sintering, or by molding and sintering.

39. A method of forming a component having a seal surface, said method comprising the steps of:

forming a metal body with a first hardness;

forming a recess in the metal body; and

forming a seal surface on the recess with a second hardness that is greater than the first hardness.

40. A method as set forth in claim 39 wherein said step of forming a seal surface with a second hardness includes work hardening the seal surface.

41. The method of claim 40 wherein the work hardening is coining.
42. The method of claim 40 wherein the work hardening is punching.
43. The method of claim 40 wherein said work hardening is performed in a single step.
44. The method of claim 40 wherein said work hardening is performed in multiple steps.
45. A method as set forth in claim 40 wherein said step of forming a seal surface with a second hardness includes work hardening the seal surface with a tool that simultaneously forms the seal surface.
46. A method as set forth in claim 39 wherein said step of forming a metal body with a first hardness includes forming the metal body by casting, or by pressing and sintering, or by molding and sintering.
47. A method of forming a component having a seal surface of a first hardness sufficient to provide an effective metal to metal seal, said method comprising the steps of:
providing a metal body having a seal surface of the first hardness; and
work hardening the seal surface to a second hardness that is greater than the first hardness.
48. An element for a fluid control system, said element having a fluid flow passage and having a seal surface, said element being made from a metal body having a first portion and having an adjacent second portion including the seal surface, said second portion of the metal body being work hardened to a hardness greater than the hardness of the first portion of the metal body to form the seal surface of the element.
49. The element of claim 48 wherein said seal surface comprises a raised bead.